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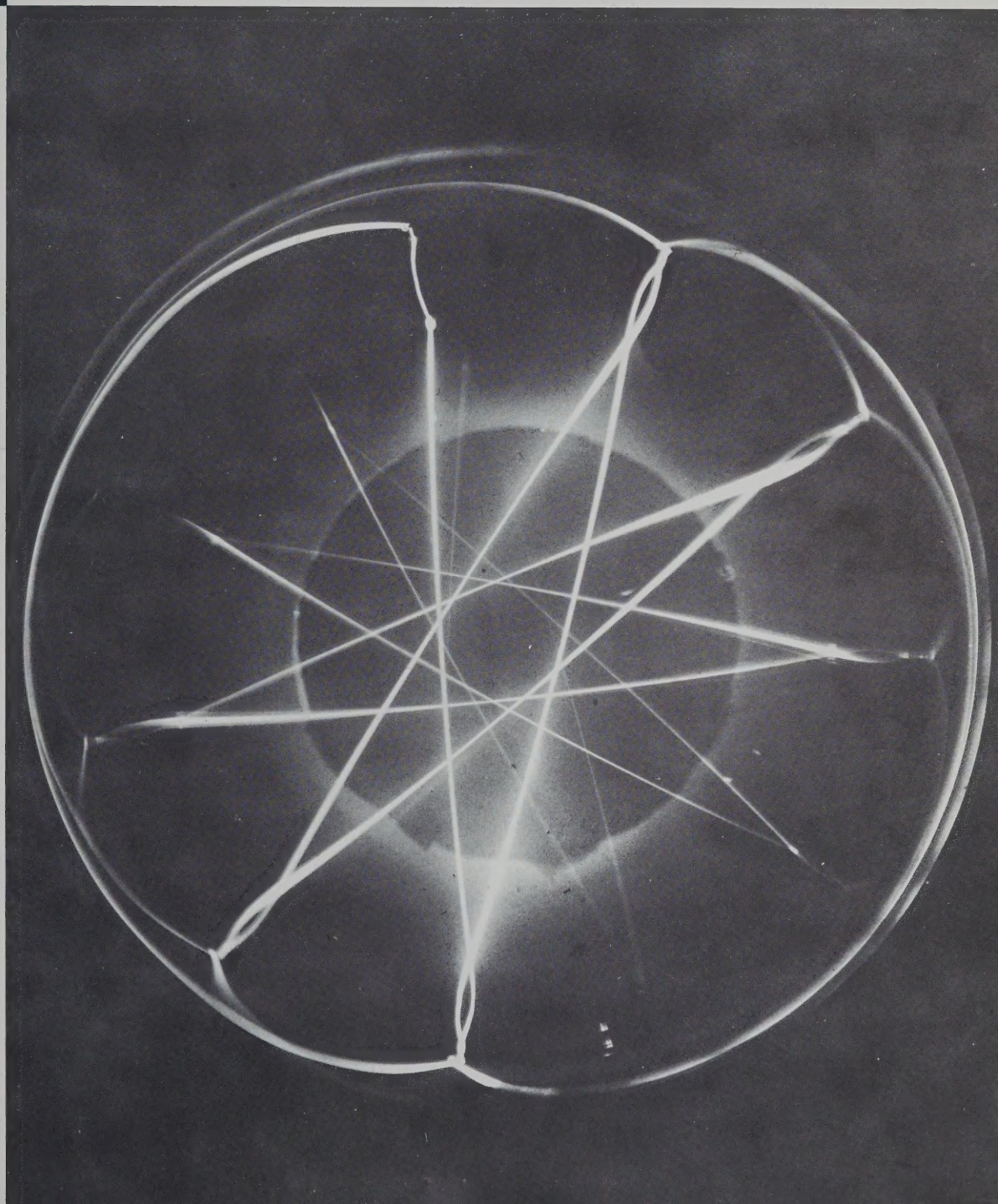
NATIONAL BUREAU OF STANDARDS

Technical News Bulletin



UNITED STATES DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS
Technical News Bulletin
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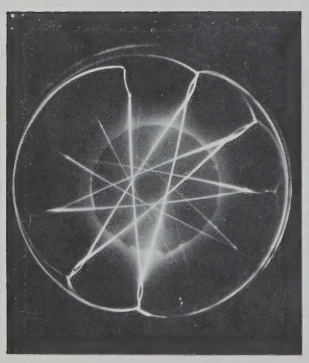

Cover: "Fish eye" photograph of a laser beam reflected many times inside a gold coated spherical nonresonant cavity. These cavities, developed as long-pass far infrared absorption cells, are used as an integral part of an automobile exhaust gas analyzer developed under the NBS Measures for Air Quality Program for measuring carbon monoxide. They will also be used in measurement of the concentration of carbon-13 isotope in a program of the Los Alamos scientific laboratory to exploit such isotope in medical applications. The main virtues of this type of cell are high radiation throughout and simplicity of construction. The laser beam shown here illustrates some of the optical properties of the spherical cavity. Photograph taken at the NBS Boulder laboratories by Friedrich Hoelzl.

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

The Institute for Basic Standards

The Institute for Materials Research

The Institute for Applied Technology

Center for Radiation Research

Center for Computer Sciences and Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

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LOCATOR-BEACON RESEARCH AIDS DOWNED FLIERS

FLIERS WHO DEPEND ON EMERGENCY LOCATOR BEACONS FOR RESCUE from crash landings will benefit from work recently completed by the Bureau and the Federal Aviation Administration (FAA) with cooperation from the Civil Air Patrol (CAP) and the U.S. Army. As a result of tests, the Bureau recommended minimum radiated power for a reliable emergency signal and developed a measurement technique for FAA use in determining the compliance of emergency locator beacons to specifications. The NBS tests also revealed that some beacons were radiating signals outside their assigned frequencies. These stray signals could jam other radio communication systems in the area. However, NBS engineers note that the addition of an interference filter to keep the broadcast signal within its proper frequency band should eliminate this shortcoming. This research was conducted to provide Federal and state agencies with a means for checking the compliance of emergency locator beacons with requirements under the law.

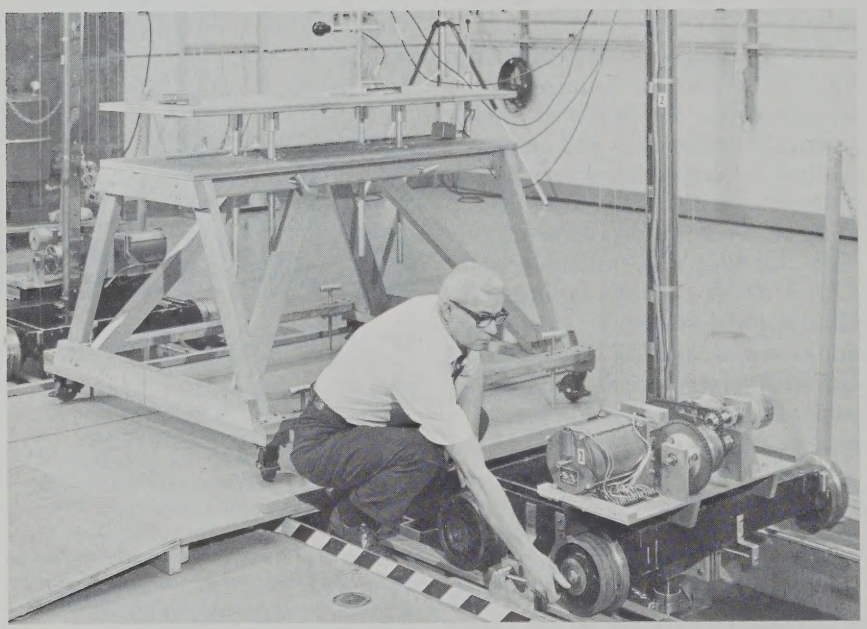
Emergency locator beacons are self-contained, battery powered units that broadcast radio signals on frequencies (121.5 and 243 MHz) which, by international agreement, are used only by downed fliers. These signals give air crash victims a radio "visibility" several miles high and several miles wide which is not obscured by rain, snow, fog or sleet. The beacons are particularly designed for general aviation airplanes which are not under the constant surveillance of FAA radar and traffic controllers. Some versions of the beacon transmitter are about the size of a small transistor radio and may be packed with a parachute or carried in the pilot's pocket. Others are designed to be attached to or built into the aircraft itself and are turned on by the impact of a crash or by immersion in water. Some will eject when a plane crashes, thus escaping damage from a possible fire.

The Bureau was asked by the FAA to develop a suitable set of specifications for radiated power from the transmitters and a reliable method for determining compliance to these specifications. With the aid of an Army helicopter from nearby Fort Carson, CAP planes, and FAA's DC-3 "flying laboratory," NBS Boulder scientists began making a careful analysis of the pattern and field strength of a typical emergency locator beacon. They built and calibrated an antenna of the same polarization as that used on most beacons and by actual flight tests confirmed the antenna characteristics as previously determined by computer calculations. The tests determined the shape of the radiation pattern from the beacon and the radiated power required to produce a reliable signal to a search plane 25 nautical miles away, flying at an altitude of 3500 feet above the ground (FAA specifications). As it is obviously impractical for the FAA to conduct a series of flight tests every time they need to check an emergency locator beacon, NBS scientists devised a method by which a beacon could be reliably checked within a small area by using an NBS calibrated antenna.

The rescue time for victims of air crashes who carried emergency locator beacons has usually been a matter of hours contrasted with days in cases where beacons were not carried. In Colorado, for example, where approximately twenty noncommercial planes crash each year, search time is estimated at four days per missing plane. The only beacon-equipped plane that ever went down in Colorado was located in nine minutes. Recently enacted legislation, sponsored by Colorado Senator Peter J. Dominick, requires new airplanes covered by the law to be factory equipped with beacons if built after December 1971. Other planes covered by the law must be beacon equipped within three years. Several states already have similar regulations in effect.

Four types of emergency locator beacons. Upper left: beacon built into the tail section of an airplane with whip antenna extending horizontally. Upper right: a beacon packaged so it may be attached to the fuselage of an airplane. Lower left: small portable beacon of the type tested by NBS. Lower right: a beacon packaged for attachment to an outside surface of an airplane. This package is designed to break away from the plane upon impact of a crash and thus escape possible damage from fire or from sinking if crash is at sea.

GAMMA-RAY SOURCE HANDLING SYSTEM



John Istock, of the Armed Forces Radiobiology Research Institute, releases a brake of a radiation source handling system designed by NBS and installed at AFRRI.

George Weiss examines the presentations from two closed circuit television cameras in the radiation room as he operates elevators that raise the cobalt-60 rods.

THE BUREAU HAS DESIGNED A GAMMA SOURCE REMOTE HANDLING SYSTEM that now is in use by the Armed Forces Radiobiology Research Institute (AFRRI), Bethesda, Md. It was designed to AFRRI specifications by project engineer James Strohlein, assisted by Louis Palombo and James McNally. Components of the system were fabricated at the Bureau's instrument shops and erected at the AFRRI site. The system raises slugs of gamma-ray-emitting cobalt-60 from storage under 16 feet of water to supply radiations for biological experiments. The system has built-in safeguards to prevent accidental irradiations; in the event of mechanism failure the source array can be returned to the bottom of the pool by gravity or by powered downhauling.

The design of the facility provides a high degree of flexibility in exposure rates. This flexibility is obtained by selection of the number of cobalt 60 slugs that are used to provide the irradiation. Up to 30 slugs can be stored in racks at the bottom of a 2 1/2-foot-wide trench pool until needed. Each slug is 10 inches long and about an inch in diameter; each is encapsulated in a stainless steel jacket and an outside aluminum jacket.

Two gamma source elevators are mounted on two independent four-wheeled carriages, which run on tracks straddling the trench. Each

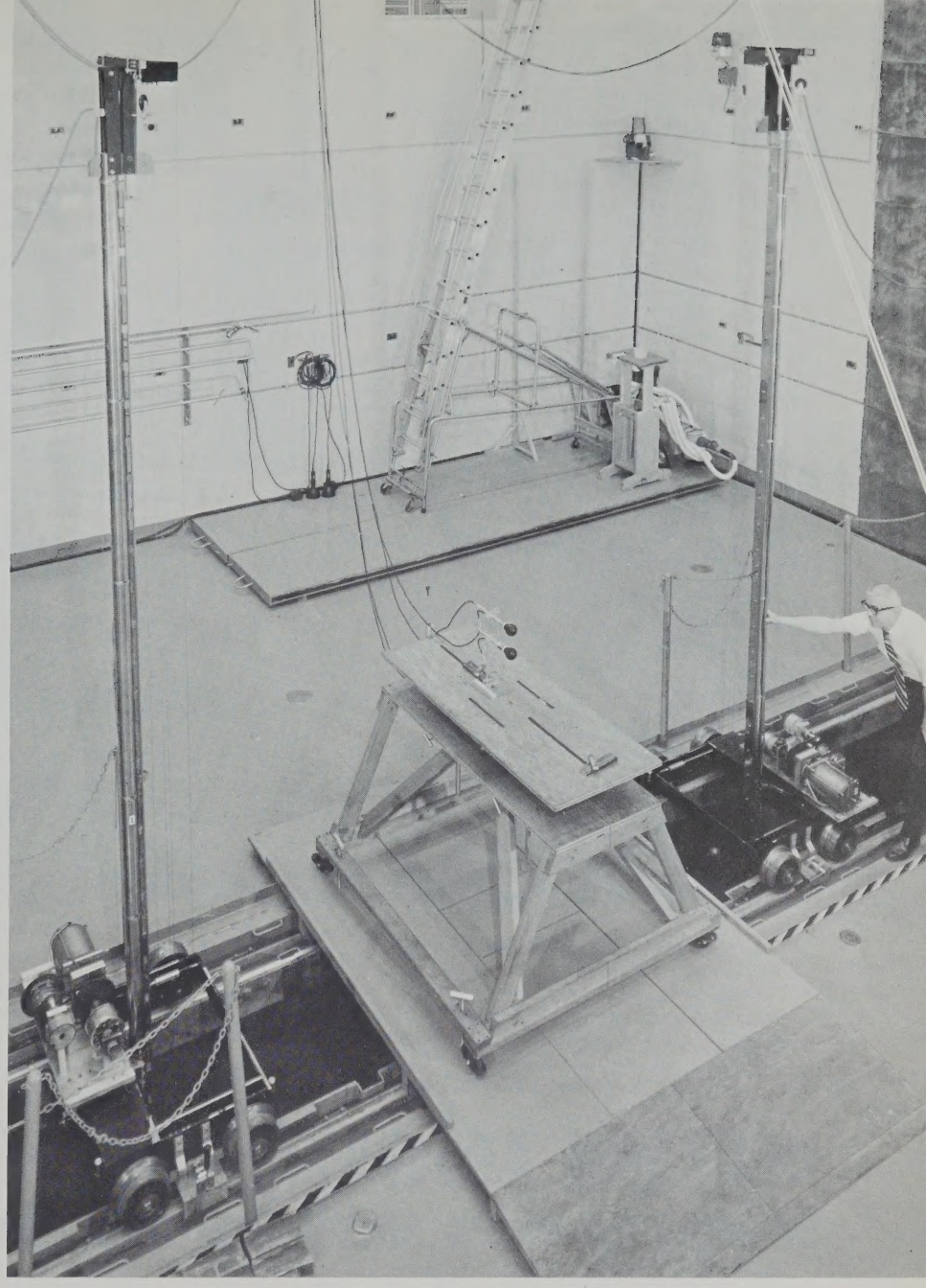
carries a column extending from the bottom of the trench, providing a rail on which a source array is guided as it is raised from the bottom of the trench to any height up to 12 1/2 feet above floor level.

A hand-operated manipulating tool, 21 feet long, permits operating personnel to safely transfer the desired number of slugs from the storage racks to the source array cages. After cages are loaded, the elevator carriages are then moved horizontally to the desired exposure position. The objects to be irradiated are then positioned as called for by the experiment, the operating personnel withdraw from the radiation room, and the massive shield door is then closed.

The operator conducts the following operations from the control room, where indicators on the console and closed circuit television permit observation of the experiment. He first automatically raises the array or arrays to the height desired. When the desired exposure time has elapsed he presses the "down" buttons until both arrays are again at the bottom, after which personnel can again enter the radiation room to remove the test subjects.

The experiments are conducted under rigid safety requirements as stipulated by the Atomic Energy Commission and AFRRI regulations, with interlock and safeguards incorporated in the system to provide positive insurance against accidental irradiation of personnel. The source cages cannot be raised until the shield door has closed and after a warning horn and flashing light have gone on in the radiation room; panic buttons in the radiation room can terminate the operation at any time. Once the experiment has started, the shield door cannot be opened until the arrays have returned underwater.

Any interlock which is actuated when a potentially unsafe condition occurs will cause the source cages to fall by gravity to the pool bottom. In the event a cage should stick during a return, an emergency downhaul procedure can be invoked to force the cages down.



John Istock manually positions one carriage of the radiation source handling system. Radiation source rods are transferred by long manipulators from storage racks under 16 feet of water into cages at the bottom of each vertical rail. The carriages are then rolled into position for the subject on the stand (two ion chambers, in this case) to receive the desired dosage when the source cages are later pulled up their rails.

NEUTRON ACTIVATION ANALYSIS:
Several Agencies and Universities Employ NBS Reactor

ONE OF THE MOST VERSATILE, HIGH NEUTRON FLUX, RESEARCH REACTORS IN THE NATION IS operated by the Bureau at its Gaithersburg site. The reactor facility offers unusual research opportunities which have been exploited by many scientists in the Washington metropolitan area for studies of the basic structure and composition of materials. Not only does the NBS staff use the reactor in carrying out its in-house programs, but cooperative work is also in progress with investigators from other Federal agencies and universities.[1,2] The reactor's experimental facilities include eleven ports with a neutron beam, a thermal neutron column, two ports with cryogenic facilities, seventeen vertical thimble tubes for specimen irradiations, a neutron time-of-flight facility, several diffractometers, and electronic counting rooms for data recording and analysis. Several Federal and university laboratories have recently joined in using the high-flux neutrons of the NBS reactor to irradiate samples for analytical investigations employing the useful technique of neutron activation analysis. These laboratories include the Federal Bureau of Investigation, the Internal Revenue Service, the U.S. Postal Service, the Food and Drug Administration, the U.S. Geological Survey, the University of Maryland, and the U.S. Army Institute of Dental Research.

Neutron activation analysis is a nondestructive technique frequently used to determine the types

FBI Special Agent John P. Riley places a sample into holder of detection apparatus as John M. Little, also of the FBI, readies the X-Y recorder for graphing the gamma-ray spectrum of the sample following neutron activation analysis.

and quantities of trace elements in materials. The procedure is to irradiate the sample material with neutrons to produce radioisotopes of the trace elements. Spectrographic analysis of the radioisotopes and comparison with either a known or otherwise identified sample, yields a quantitative value of the element present in the material. At the NBS reactor materials may undergo irradiations producing neutron activation in a thermal column, a thermal beam facility, or any of the several irradiation thimbles.

The Federal Bureau of Investigation employs the reactor's neutrons in the activation of such materials as stainless steel wires (that were used to tie a robbery victim); hair, fingernails, and body organs (that might contain over-abundances of arsenic or mercury that are agents sometimes used as chronic, long-term poisons); and paraffin casts of a suspect's hands (that would show if significantly greater amounts of barium and antimony are on one hand as a result of discharging a handgun).

The Internal Revenue Service uses the NBS reactor's facilities to substantiate evidence of criminal activities related to the avoidance of paying taxes. Their work becomes involved in such materials as narcotics, illicit liquors, soil (as from around a still), objects of art (old oil paintings and sculptures, for example), as well as materials that would relate to the robbery or murder of a Revenue employee.

U.S. Postal Service researchers at the reactor use neutron activation analysis to trace the origin of narcotics and bombs sent through the mail, murders of postal employees, burglaries of post offices, and stamp and money order forgeries. In the case of parcels sent through the mail, researchers can trace the paper wrapping and boxes to their manufacturers (and hence their purchaser's general location) by analysis of the paper's components, as each manufacturer has traces of specific elements in his paper which permits identification. Wire, rope, tape, stuck hair, and other fragmentary particles may also be analyzed to verify that a suspect was involved with the mail under investigation.

Small quantities of impurities and trace elements in foods, drugs, and household products are being examined at the NBS reactor by the Food and Drug Administration. Their studies include the determination of halogens in antibiotics and of hydrofluoric acid in rust and stain removers. Also under study are the determinations of trace toxic elements such as mercury and cadmium in foods, and arsenic and antimony in detergents. The effect of vanadium and bromine on animal tissues are also being investigated.

The U.S. Geological Survey researchers are analyzing rocks and minerals for traces of such elements as manganese, scandium, lanthanum, chromium, arsenic, antimony, mercury, tantalum, thorium, and the rare earths. Most of the work is performed on the request of field geologists who analyze land formations and their probable origins from basic geochemical studies of magmatic crystallization-differentiation and mechanisms of post-magmatic alterations. Future studies are planned for determining the quantities of the elements tantalum, hafnium, antimony, and tungsten in lunar samples.

In a preliminary investigation, a University of Maryland professor is undertaking a study to determine the quantitative amounts of mercury in Chesapeake Bay oysters using neutron activation analysis. Although some measurements have been taken, the efficiency of the technique is being advanced in order to obtain more accurate measurements. The general procedure is to freeze-dry oyster samples and irradiate them. The samples are then acid-digested and the mercury removed by isotopic exchange for quantification.

Special Agent John P. Riley of the FBI inserts a sample into the injector chamber of the NBS reactor for activation analysis. The sample is sped into the core of the reactor through one of the tubes by carbon dioxide gas pressure and is returned after a specified time through the other tube.

Another University of Maryland group is engaging the neutron activation analysis facilities of the NBS reactor in the analysis of trace elements in the environment. They are analyzing particulate matter in air samples from Boston, Massachusetts, and the South Pole. In addition to particulate matter, they are also analyzing the pollutants originating from crude oils and their distillates. A side project is the

(*Continued page 207*)

June Maienthal using the cathode ray polarographic instrumentation. With this polarograph a linear voltage sweep is applied in either the cathodic or anodic direction during the last 2 seconds of the life of a mercury drop which is mechanically detached from the capillary every 7 seconds. The peak resulting from the electrolysis of the sample and which is proportional to the concentration of that species is displayed on the cathode ray tube. Peaks differing by less than 100 mV may be resolved and in some cases sensitivities of a few ppb can be obtained.

POLAROGRAPHY— A TOOL FOR ECOLOGISTS

METHODS OF GREAT SENSITIVITY AND SELECTIVITY are usually required for the analysis of polluted water and air. E. J. Maienthal, R. A. Paulson and J. K. Taylor have found polarographic analysis to be an extremely efficient procedure for determining trace amounts of pollutants.[1,2] Polarographic equipment is relatively inexpensive, sample preparation is moderate and detection levels for some metals are as low as parts per billion.

Briefly, polarography is a procedure for determining the concentration of an ion in solution by measuring its electrolysis current at a known voltage. One of the electrodes is a glass capillary which extends into the solution being analyzed and from which small drops of mercury are periodically emitted. From the current-voltage curve produced during electrolysis both the species and concentration of a material may be determined.

Several studies conducted at NBS demonstrate the applicability of the polarographic procedures to different types of air and water pollution. Contaminants such as aluminum, arsenic, cadmium, copper, indium, iodine, lead, tellurium, and zinc were determined in such varied matrices as laboratory distilled water, reactor cooling water and river water. For example, zinc was determined at 8 ppb in aquarium water and at 5 ppb in distilled water. Polarographic analysis has also been used to study a variety of air pollution problems. Samples were collected on conventional filters which were then ashed or, in favorable cases, from which the contaminant could be extracted by leaching.

In collaborative studies with the National Center for Air Pollution Control, the NBS investigators found a good correlation between their determinations of lead, cadmium, iron, and copper in atmospheric samples and the determinations of other researchers using atomic absorption methods. Polarography

may be further applied to pollution analysis in industrial or processing plants to insure that contaminants do not reach hazardous levels. Work correlating the findings of polarographic analysis with determinations resulting from the use of other analytical techniques is being continued. Also underway are further investigations into more sensitive and more efficient methods for determining organic substances.

Of the many polarographic techniques available, cathode ray polarography and pulse polarography are particularly suited to trace analysis because of their higher sensitivity levels. Both methods have sensitivities at the 10^{-7} to 10^{-8} molar level in the final solution. In cathode ray polarography, a linear voltage sweep is applied in either the cathodic or anodic direction during the last two seconds of the life of a mercury drop which is mechanically detached every seven seconds. The peak resulting from the reduction of the element in question, and which is proportional to the concentration of that element, can then be displayed and measured on the cathode ray tube of a fast recorder. Elements with a reduction potential separated by less than 100 mV may be resolved in the same solution.

Typical Analyses Made by Cathode Ray Polarography

Element	Matrix	%	Separation
Al	thin film alloys, high purity metals, reactor water, lubricating oils	<0.00002 – 2.5	extraction, volatilization of matrix, direct, or direct after ignition
Sb	brass and cast irons, Sb-Bi thin film	0.005 – 95	direct or extraction
As	ammonium dihydrogen phosphate	0.0001	direct
Bi	metals, alloys, thin films, botanicals, rocks	0.00001 – 70	direct or extraction
Br	$KClO_3$	0.001	direct
Cd	metals, alloys, botanicals, rocks	0.000005 – 95	direct or extraction
Cr	thin film and wire	20	direct
Cu	organic complexes, rocks, water, brasses, metals, alloys, lubricating oils, botanicals	0.000002 – 95	direct or extraction
In	alloys	0.004 – 70	direct
I	water	0.00001	direct
Fe	reactor water, glasses, lubricating oils, botanicals	<0.00001 – 0.05	direct or extraction
Pb	metals, alloys, botanicals, lubricating oils, rocks	0.00002 – 90	direct or extraction
Ni	metals, alloys, thin films, glasses, botanicals, organics, lubricating oils	0.00005 – 97	direct or extraction
Sn	stainless steels	0.004 – .023	precipitation or extraction
Te	metals and alloys	0.00003 – .07	precipitation or matrix volatilization
Tl	Pb alloys	0.00002 – 80	direct or extraction
Ti	steels, cast irons, glasses	0.0003 – .3	precipitation or extraction
Zn	metals, alloys, organic complexes, water	0.0000008 – 40	direct

Pulse polarography involves the application of short voltage pulses against a linearly increasing background voltage during the beginning of the mercury drop growth. The faradaic current is measured near the end of the drop life. As the charging current and current from preceding reductions are allowed to decay prior to measurement, greater sensitivity and tolerance to preceding reductions is obtained. Reductions separated by 40 mV may be resolved.

Used extensively in Europe, polarography has not been widely employed in the U.S. The reasons for this are not clear. The fact that a high degree of training and considerable experience may be required to perform proper polarographic procedures perhaps is a limiting factor. Any element which can participate in a redox reaction should be determinable by polarographic methods. Tables describing typical behavior of most of the elements are available. The cost of the instrumentation is modest and the sample size used is generally smaller than that required for many methods of analysis. The sample size can range from 0.2 mg on up, although the average specimen is under 100 mg. Determinations of trace amounts usually require 1-2 g of sample. Preparation of a sample for analysis is moderate and several elements may be determined in the same solution if the reduction potentials are separated by 40 to 200 mV (depending on the type of polarographic instrumentation). A problem in sub-ppm or ppb level determinations is the blank arising from impurities in reagents used for sample preparation or from atmospheric or container contaminants.

[1] Maienthal, E. J. and Taylor, J. K., Polarographic Methods in Determination of Trace Inorganics in Water, Advances in Chemistry Series, No. 73, 1968.

[2] Maienthal, E. J., Paulson, R. A. and Taylor, J. K., Polarographic Analysis of Air Pollutants, a talk presented at the April 14-18, 1969, meeting of the American Chemical Society in Minneapolis, Minnesota. To be published.

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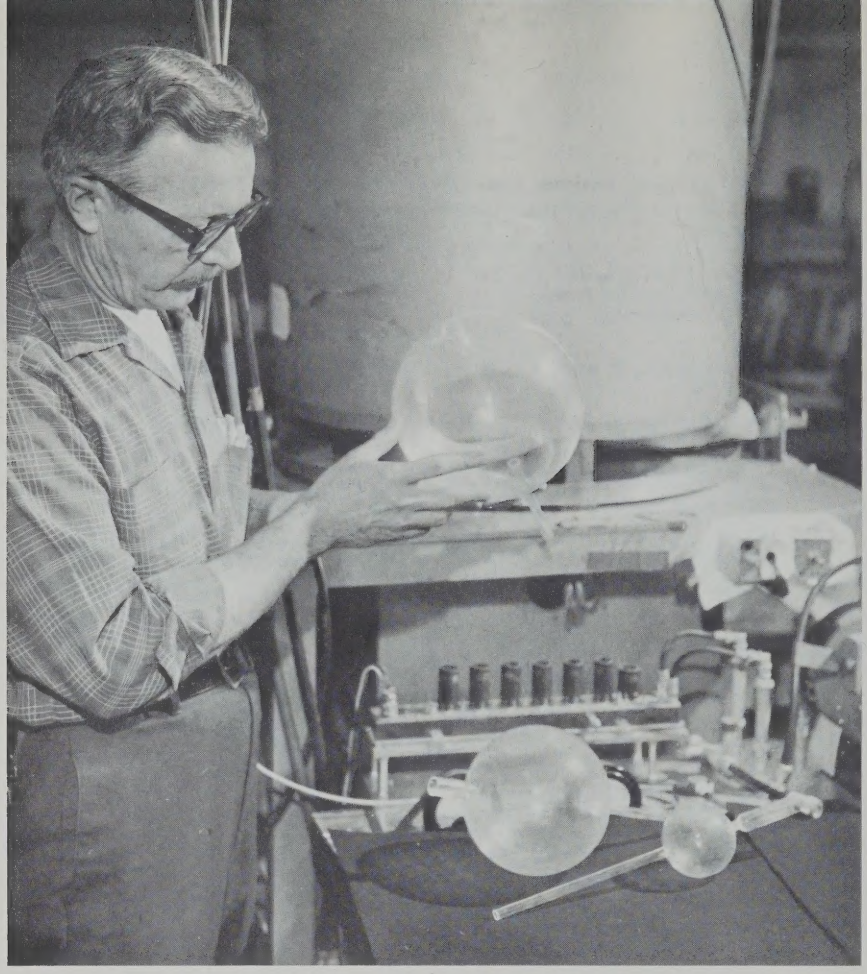


Howard Bell examines the largest storage bulb (20-cm diameter) for the hydrogen maser. Other polyetrafluoroethylene-coated bulbs used include the 7.5- and 16-cm bulbs on the table, in front of the cylindrical magnetic shield that contains the maser cavity.

HYDROGEN FREQUENCY MEASURED ACCURATELY

ONE OF THE MOST ACCURATE MEASUREMENTS MADE OF A SIGNIFICANT PHYSICAL PROPERTY HAS BEEN REPORTED[1] by the Bureau's Boulder Laboratories, in cooperation with the Smithsonian Astrophysical Observatory (SAO), Harvard University, and the National Aeronautics and Space Administration (NASA).

The physical property involved transitions between higher and lower energy states in atoms. As an atom switches from one state to another, it emits or absorbs energy of a certain frequency. The NBS frequency measurement, for an unperturbed hyperfine transition in atomic hydrogen, carried 12-digit accuracy. The measurement of the transition:

$$(F = 1, m_F = 0) \leftrightarrow (F = 0, m_F = 0)$$

for hydrogen gave a value of 1420 405 751.768 Hz with a one-sigma estimated uncertainty of 0.002 Hz.

Two separate experiments using different methods resulted in values differing by less than the evaluated accuracy. The uncertainty of the measurements is analogous to measuring the circumference of the earth with an uncertainty of three thousandths of an inch.

A unique opportunity to make these measurements occurred while researchers from the cooperating organizations were evaluating the stability of hydrogen masers and cesium-beam frequency standards. Researchers are interested in hydrogen masers as potentially improved frequency standards. The measurements were traceable to the NBS primary frequency standard NBS-III.[2]

Hydrogen masers do not oscillate at the frequency of unperturbed hydrogen because of cavity pulling, spin exchange, magnetic fields, second-order Doppler effects, and atomic collisions with the walls of the storage bulb (i.e., the wall shift). However, all but the wall shift can be measured with uncertainties of considerably less than one part in 10^{12}.

The problem then reduces to performing a good wall-shift measurement, often done by measuring the maser frequency when different sizes of storage bulbs are substituted. (As the bulb size increases, the hydrogen atoms collide less frequently with the walls. With an infinitely large bulb, there would be no collisions, and thus no wall shift. Extrapolating the measured frequencies to an infinitely large bulb size gives the zero-wall-shift frequency.)

Since the amount of wall shift is not a universal constant, it must be measured for each experimental setup, preferably at the same time that the frequency measurements are made. While several measurements of the wall shift and the hydrogen frequency were already reported in the past, the NBS experiment was the first which satisfied the criteria of simultaneous wall-shift and frequency measurements for a large number of bulb sizes. Many of the previous measurements disagreed among

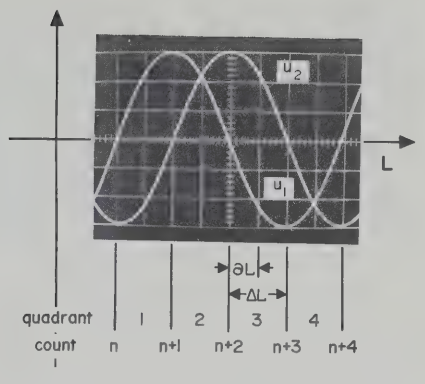
(*Continued page 205*)

FRINGE-COUNTING ULTRASONIC INTERFEROMETER DEVELOPED AT NBS

A FRINGE-COUNTING ULTRASONIC INTERFEROMETER has been developed at NBS for the continuous, automatic measurement of length changes of mercury columns.[1] The apparatus, designed and constructed by P. L. M. Heydemann, is based on phase sensitive detection of pulses. The interferometer can follow large changes in lengths (4 to 100 cm) while maintaining a resolution of approximately one part per million. In addition to the greatly increased resolution offered by the interferometer, it has the advantages of simplicity and low cost of construction. The apparatus fills a need for the automatic, continuous measurement of mercury column lengths in precision manometers and should prove valuable for other applications such as obtaining speed of sound data in liquids.

In operation the interferometer generates a pulse with a carrier frequency of 10 MHz. This pulse is fed into a quartz transducer coupled to the mercury column. The pulse travels through the length of the column, is reflected at the mercury surface and sent back to the transducer, where it is again reflected into the column. Each time the pulse hits the transducer a small amount of the sonic energy is converted to an analog electrical signal, and phase sensitive detected.

The instantaneous amplitude of the detected echo depends on the phase difference between the echo pulse and a reference signal connected to the phase sensitive detector; that is, as the length of the column changes, a phase shift occurs altering the amplitude of the pulse. During each repetition of an echo sequence the amplitude of a particular echo is sampled and held until the information is updated during the next sequence. By sampling the same echo during each sequence, the amplitudes of the pulses give an almost continuous record of length changes.



Output signals from the phase sensitive detectors of the NBS-developed fringe counting ultrasonic interferometer for measuring length changes in mercury columns. By interpolation, at a wavelength of 150 μm (10 MHz), determinations of length changes with a resolution of a part per million are possible.

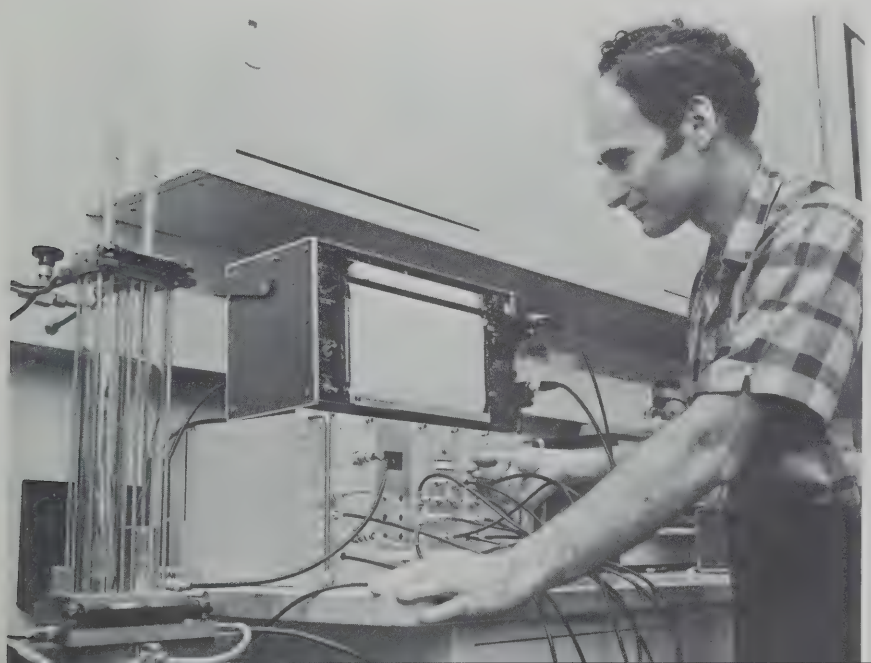
A commercial up/down counter with one count per quadrant is used to continuously monitor the change in length of the sample. Another counter automatically counts down to the echo selected for fringe counting.

Two detectors are used, one of which receives a reference signal 90° out of phase with the other. Their output signals are used to discriminate between increasing or decreasing length of the sample.

At a carrier frequency of 10 MHz, the wavelength in mercury is about 150 μm. Using the seventh echo a resolution of 3 μm per count can be achieved. An increase in the resolution can be obtained, however, by extracting additional phase information from the output signals of the detector. By extrapolation, the detector voltages yield change of length data within a quadrant. Resolution of better than 1 part per

(*Continued page 206*)

Dan Buchalter of the NBS staff prepares the fringe counting ultrasonic interferometer to measure length changes of the manometer at left.



POINT PLEASANT BRIDGE COLLAPSE

On December 15, 1967, the bridge connecting Point Pleasant, West Virginia, and Kanauga, Ohio, collapsed into the Ohio River, carrying 46 persons to their deaths. NBS experts played a prominent role in the laboratory examinations of steel members from the failed structure, providing key findings as to the underlying cause of the disaster. In brief, NBS found that corrosion in the head end of an eyebar led to the development of stress corrosion cracks; over a period of years one of these reached a depth of about 1/8 inch. At this point the metal, of a type having low resistance to fracture once a "notch" had been established, failed catastrophically, causing the bridge to collapse. NBS work in this investigation was done at the request of and with the financial support of the Bureau of Public Roads, Department of Transportation.

The bridge, built in 1928, was of the eyebar chain suspension type, with a 700-foot center span flanked by two 380-foot side spans. In essence, the eyebars performed the same supportive function as a cable in a suspension bridge. Although it is not uncommon for eyebars to be used in bridge construction, it is rare for the stiffening trusses of both the center and side spans to be framed into the eyebar chain. In fact, only three bridges have been built to this configuration: the collapsed Point Pleasant span; another 75 miles upriver at St. Marys, West Virginia, and the third in Brazil. The St. Marys bridge was closed about a year after the Point Pleasant disaster, and will soon be replaced with a new bridge of modern design. The Pt. Pleasant bridge has already been replaced.

The eyebars used in the bridge are 45-55 feet long, up to two inches thick, and 12 inches wide in the shank. At either end there is a circular enlargement, pierced by a hole about 15 inches in diameter through which fastening pins were placed as the bridge was assembled. The bars were made of heat treated, rolled carbon steel, with forged heads, and were designed to break at ultimate loading in the shank, not the head.

Inspection of the wreckage brought to light an eyebar that had broken through the eye. The nature of the fracture showed that it had occurred under normal service loads, indicating that it was the initial fracture in the collapse. Fortunately, both pieces resulting from that fracture were recovered from the river by the Army Corps of Engineers, and brought to NBS for analysis. The Bureau was selected for this important phase of the investigation because of its competence in metallurgy and long experience in failure analysis. The "plan of attack" employed by NBS in examining the eyebar pieces was formulated in advance and agreed upon by the "parties of interest" (the states of West Virginia and Ohio, the designers and builders of the bridge, and two independent consulting engineering firms).

Visually, the two fractures on opposite sides of the broken eye are quite different. On one side the fracture is a straight line, the surface exposed by the break is quite brittle in appearance, and there is little evidence of plastic deformation adjacent to the break. The other fracture does not follow a straight line, has a very rough exposed surface, and shows extensive plastic deformation in the adjacent areas. The different appearance of the two fractures results from their nature and the sequence of events. The straight line fracture, an almost instantaneous event once the notch reached the critical depth of about 1/8 inch, occurred first. The failure then shifted an unsupportable load to the other side of the eye, which deformed extensively before breakage occurred. Careful cleaning of the specimens, followed by microscopic examination of various surfaces, revealed cracks penetrating into the metal from the hole surface, particularly in the area near the existing straight-line fracture, and in an area where there was heavy corrosion. The cracks not involved in failure were oxide-filled, indicating they had been open for some time.

Although the cracks had existed for some time, the location of the flaw was inaccessible to inspection. It is generally agreed that it could not have been detected by any inspection method known without disassembly of the eyebar chain. Further, in 1927, when the bridge was designed, the phenomenon of stress corrosion was not known to occur in the classes of bridge

NBS Workshop

ON ITS RESEARCH AND SERVICES FOR SCIENCE, ENGINEERING, INDUSTRY AND GOVERNMENT IN HAWAII

On August 24, the National Bureau of Standards will hold a workshop in Honolulu on "SCIENTIFIC AND TECHNOLOGICAL SERVICES FOR HAWAII: A Cooperative Federal-State Effort," as a part of our regular program to familiarize scientific, industrial, commercial and government communities with the nature and types of NBS technological services available to them. At the same time, these programs help us understand their problems and enable us to tailor our scientific and technical programs more specifically to their needs.

I cordially invite all of our friends in Hawaii, as well as the friends of Hawaii, to participate in our workshop. It will be held in conjunction with the initiation of our new and enlarged time and frequency services from radio station WWVH, now being broadcast from our new site on the island of Kauai, and simultaneously with the Fourteenth Annual Conference of the Western States Weights and Measures Association.

Details of the program are described below. I sincerely hope that you will be able to join us, for it is principally through personal interaction that we can most satisfactorily convey to you useful information about NBS services, and you in turn can help us shape our programs to meet your needs.

If you cannot join us in person in Hawaii, then I invite you to inspect the program topics that follow, read the section "For Further Information", and call upon the key man listed for whatever information you may need.

Sincerely,
Lewis M. Branscomb
Director

Scientific & Technological Services for Hawaii

A Cooperative Federal-State Effort

Tuesday, August 24, 1971

Hilton Hawaiian Village Hotel, Gold Room

Honolulu, Hawaii

Welcoming Address **The Honorable John A. Burns**
Governor of Hawaii

Response **The Honorable James H. Wakelin, Jr.**
Assistant Secretary for Science and Technology
U.S. Department of Commerce

Invocation **Rt. Rev. Monsignor Charles Kekumano**

MORNING PROGRAM: Research and Services for Science and Engineering

Dr. Louis G. Nickell, Chairman, Governor's Advisory Committee on Science and Technology, Presiding

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Dr. Lewis M. Branscomb, Director, National Bureau of Standards
Introduction to the National Bureau of Standards, its Goals and Services

Dr. J. A. Barnes, Chief, Time and Frequency Division, NBS
Time and Frequency Services of the NBS—Cooperation Between the States of Colorado, Hawaii and the NBS

Dr. K. Aa. Strand, Scientific Director, U.S. Naval Observatory
The U.S. Navy and WWVH

Professor John T. Jefferies, Director, Institute for Astronomy, University of Hawaii; and

Dr. Peter L. Bender, Fellow, Joint Institute for Laboratory Astrophysics, Laboratory Astrophysics Division NBS, Boulder, Colorado
Hawaii—NBS Collaboration in Astronomy and Astrophysics

LUNCHEON PROGRAM: Dedication of the New WWVH Facilities and Broadcast Services to the Service of the Nation

AFTERNOON PROGRAM: Research and Services for Industry, Government, Consumer and Seller

Mr. Fred C. Erskine, Chairman, Hawaii State Board of Agriculture and Director, Weights and Measures, Presiding

---

Dr. L. M. Branscomb, Director, National Bureau of Standards
Opening Remarks

Mr. Jack O. Padrick, Director, Office of Business Services
How Your Department of Commerce Field Office Can Help Your Business

Dr. E. Passaglia, Chief, Metallurgy Division NBS
NBS Services to Industry for Improved Materials and Standards

Mr. H. F. Wollin, Executive Secretary, National Conference on Weights and Measures, and Assistant Chief, NBS Office of Weights and Measures; and

Mr. G. E. Mattimoe, Chief, Division of Weights and Measures, Department of Agriculture, State of Hawaii
Weights and Measures in Hawaii—A Model State-NBS Cooperative Effort

Mr. G. A. Rowland, Chief, State Codes and Standards Section, NBS
Building Performance Measurement Services Available from the National Bureau of Standards/National Conference of States on Building Codes and Standards

Dr. L. M. Branscomb, Director, National Bureau of Standards
The U.S. Metric Study—The Impact Upon the U.S. of Increasing Worldwide and Domestic Use of the Metric System

Dr. James H. Wakelin, Jr., Assistant Secretary for Science and Technology
Closing Remarks

FOR FURTHER INFORMATION

TIME AND FREQUENCY SERVICES

The NBS Time and Frequency Division develops, maintains, and disseminates frequency and time interval standards and time scales. Time and frequency are unique among the many standards maintained by NBS in that they are not distributed by secondary standards carried to and from laboratories, but are transmitted by radio direct to the users. For this purpose NBS operates four radio stations that provide this dissemination service on a continuous, world-wide basis. In addition, an experimental system is being developed and tested whereby extremely precise time signals are transmitted on network television, but only decoded and displayed on those receivers having the necessary extra electronics. For information on time and frequency services, contact:

Dr. J. A. Barnes
Chief, Time and Frequency Division
National Bureau of Standards
Boulder, Colorado 80302
Phone (303) 447-1000, x3294

DEPARTMENT OF COMMERCE FIELD OFFICES

The Office of Business Services (OBS) is the principal Department of Commerce contact with the business community for:

- business information services
- aiding business in the use of these information services
- promoting business community participation in the resolution of the nation's economic and minority business problems.

OBS provides local assistance and service to the business community in obtaining and utilizing information and related business aids of the Department of Commerce and other agencies, performs the field work involved in the programs of the Bureau of Domestic Commerce and Bureau of International Commerce, and provides special services for other Commerce organizations. In addition, OBS carries out the domestic trade fair and international exposition functions of the Bureau of Domestic Commerce, and provides staff support for national and regional export expansion councils.

Direct contact with the business community is insured through the activities of the 42 OBS field offices in major cities throughout the country. The offices provide information and advisory services on the programs of all agencies of the Department of Commerce.

For information regarding any services from the Office of Business Services, contact:

Mr. H. Tucker Gratz
Field Office Director
286 Alexander Young Building
1015 Bishop Street
Honolulu, Hawaii 96813
Phone: (808) 546-5977

or

Mr. Jack O. Padrick
Director, Office of Business Services
Department of Commerce Building
Washington, D.C. 20230
Phone: (202) 967-3641

NBS RESEARCH AND SERVICES FOR INDUSTRY

NBS and industry often cooperate in formal programs of mutual interest. One example of such cooperation is an NBS project sponsored by the American Iron and Steel Institute. About 7 years ago the Institute asked NBS to undertake a study of the corrosion of steel pilings in

tidal sea water. Since the results of such a study would be of interest to the whole industrial community, NBS agreed to undertake the work. Mutual conferences established the details of this 15 year program, and the first grants were made by the Institute in 1966.

The 102 pilings provided by the Institute—each 35 feet long and weighing 1680 pounds—were placed in site at Dam Neck, Virginia, with the essential cooperation of the Navy Sea Bees. Each year NBS specialists visit the site to make visual inspections and electrical polarization measurements of the pilings. The polarization measurements will be correlated with the observed corrosion behavior. Next year, again with the help of the U.S. Navy, about a third of the pilings will be withdrawn and their corrosion will be measured. The results, being of widespread interest, will be published in the open literature.

The Bureau was approached for this project because of its long experience and proven competence in corrosion research. NBS work on the corrosion of various metals in soil began before 1920. Over 100 burial sites were developed in which such factors as the acidity, resistivity, and composition of the soil were studied with respect to corrosion. Analysis of data from these sites showed that soil resisitivity and acidity were the factors most important in determining the corrosiveness of a soil, and five sites were selected as being representative of the various soils encountered in the U.S.

In addition to cooperative programs such as that just described, NBS also conducts an active Research Associate Program. A Research Associate, selected from the staff of the sponsoring organization, normally spends one to two years or longer at NBS working toward the solution of a specific problem of mutual interest to his organization, to the industry, trade or profession represented, and to the Bureau.

For further information on NBS-Industrial interactions, contact:

Mr. P. R. de Bruyn
Industrial Liaison Officer
Room A402 Administration Building
National Bureau of Standards
Washington, D.C. 20234
Phone 301-921-3591

STANDARD REFERENCE MATERIALS

The standard reference materials (SRM's) prepared and distributed by NBS are well characterized for chemical composition or for a particular physical or chemical property. SRM's are used in calibrating and evaluating measuring instruments, methods, and systems, or in producing scientific data that can be referred readily to a common base. Over 700 different samples are now available through this program, covering such diverse materials as steels of known alloy content, glass spheres of known size for calibrating sieves, and standard magnetic tapes for the computer industry. New demands are continually being placed upon the program, and new standards are being issued to meet these demands. For example, high purity cholesterol was issued at the request of the College of American Pathologists, and other standards in the fields of clinical and biochemistry have been issued or are now undergoing preparation and analysis. Catalogues and price lists are available from the Office of Standard Reference Materials, and announcements of new standards are made in the NBS Technical News Bulletin. Inquiries concerning SRM's should be made to:

R. W. Seward
Office of Standard Reference Materials
National Bureau of Standards
Washington, D.C. 20234
Phone: 301-921-2045

WEIGHTS AND MEASURES

The goal of the NBS Office of Weights and Measures (OWM) is to assure equity and fairness in trade. The OWM provides protection equally to buyers and sellers, and serves to establish measurement accuracy and uniformity in the Nation's commerce. Its concern extends to the scale in the supermarket, the neighborhood gasoline pump, the taximeter, the package in the marketplace, the farm milk tank, the truck scale, the fuel-oil meter—almost every weight and measure and weighing and measuring device that is used in commerce. The primary service of the OWM is the assistance offered to the states in the areas of laws and regulations, standards and laboratories, testing equipment and procedures, measurement studies, packaging practices, technical training, information dissemination, and conferences and meetings. Each state has an official of weights and measures, who exercises quantity control in commerce, and a State Weights and Measures Laboratory. The Laboratory is equipped with a complete set of standard weights and measures supplied by NBS. For information regarding these services, contact:

G. E. Mattimoe
Deputy Director of Weights and Measures
Department of Agriculture
1428 South King Street
P.O. Box 5425
Honolulu, Hawaii
Phone: (808) 941-3071

or

T. M. Stabler
National Conference on Weights and Measures
National Bureau of Standards
Washington, D.C. 20234
Phone: (301) 921-2401

BUILDING CODES AND STANDARDS

The National Conference of States on Building Codes and Standards (NCSBCS) is composed of delegates from the various states who have organized to help solve

FOR FURTHER INFORMATION
Cut Out postcard, check items of interest, and add a 6-cent stamp before mailing

Please send me information on the checked items:

- ☐ NBS Publications
- ☐ Standard Reference Materials
- ☐ National Standard Reference Data System
- ☐ Time and Frequency Services
- ☐ Metric System Bibliography

Name _____
Affiliation _____
Address _____
City _____ State _____ Zip _____

building codes and standards problems within and among their states. As a technical advisor, NBS shares its talents and skills with the states in meeting their problems. NCSBCS provides a vehicle through which the states can discuss building problems faced by regulatory officers of the states. The Conference also provides a mechanism for developing and exchanging solutions to identified problems. NCSBCS is concerned with developing programs leading to the adoption and administration of uniform comprehensive building codes and standards, developing an effective voice for state officials in the American National Standards Institute, and developing standard and code practices that will encourage the introduction and uniform recognition of innovations in building materials. It also supports the evolvement of comprehensive training and educational programs at recognized educational institutions, the further utilization of the scientific environment of the NBS Building Research Division, and the fostering of cooperation among government officials concerned with building regulations. For information contact:

Robert Hasegawa
Director, Labor & Industrial Relations
Honolulu, Hawaii 96801

or

G. A. Rowland
State Codes and Standards
National Bureau of Standards
Washington, D.C. 20234
Phone: 301-921-3447

THE U.S. METRIC STUDY

In 1968 the Congress authorized a 3-year study of the metric system, for which major responsibility was delegated to NBS. The basic issues of the study are: the present impact within the U.S. of increasing worldwide and domestic use of the metric system; the future impact, assuming that the use or nonuse of the metric system continues as at present, with no coordination among the various sectors of the society; and, what would be the effect of a coordinated National program to increase the use of the metric system. The study is designed to aid the Secretary of Commerce in making recommendations to the Congress on the action, or lack of action, required by this country regarding use of the metric system. For further information, contact:

D. V. DeSimone
Director, U.S. Metric Study
National Bureau of Standards
Washington, D.C. 20234
Phone: (301) 921-3611

TECHNICAL PUBLICATIONS
The National Technical Information Service

The National Technical Information Service (NTIS) is one of the U.S. Government's largest processors of technical information for the public. NTIS is simplifying and improving access to this information, and thus is helping the nation obtain a maximum return from Federal research and development efforts. NTIS has a dual responsibility: to coordinate the DoC business and technical information activities, and to collect, announce, and disseminate technical reports and data. Over 50,000 technical reports enter the NTIS system each year. These reports are the result of research work done under Federal funds by over 150 agencies within the Federal Government; the subject matter covers scientific, social, and economic research. Over 3 million copies are distributed annually in microfilm and paper copy. Key announcement services include Government Report Announcements, Government Reports Index, Government Reports Topical Announcements, and Fast Announcement Service. For information on any NTIS services, contact:

Sam Tancredi
National Technical Information Service
Springfield, Virginia 22151
Phone: (703) 321-8500

NBS PUBLICATIONS

The goal of the National Bureau of Standards—to strengthen and advance the Nation's science and technology and to facilitate their effective application for public benefit—reflects the Bureau's dual role, both as an instrument of government and as a primary resource for the Nation's scientific and technological endeavors. In this work, NBS programs serve a number of communities:

- Science and Engineering (promoting more accurate, meaningful and compatible technical data and measurements)
- Industry and Government (promoting more effective use of science and technology)
- Consumers and Sellers (promoting equity in trade and confidence in a competitive marketplace)
- Public Safety (advancing effective test methods and standards for protecting the public from hazards identified by Congress)

The results of many NBS programs are printed in either the Bureau's own series of publications or in the journals of professional and scientific societies. Bureau publications are grouped into two periodical and 10 nonperiodical series, including the Technical News Bulletin, the Journal of Research, and the Building Science Series to name just a few. Of special interest is a new consumer information series—guides on fibers and fabrics, tires, and adhesives have already been published, with more to come. Information on all NBS publications is available from:

W. R. Tilley
Room A600, Admin. Bldg.
National Bureau of Standards
Washington, D.C. 20234
Phone: (301) 921-2493

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National Bureau of Standards
Washington, D.C. 20234

FOR FURTHER INFORMATION
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Close-up view of the eyebar responsible for the Point Pleasant Bridge collapse, and an artist's drawing of the bridge. The straight line fracture, an almost instantaneous event once a notch, caused by stress corrosion, reached a critical depth of about 1/8 inch, occurred first. The failure then shifted an unsupportable load to the other side of the eye, which deformed extensively before breakage occurred.

material used under conditions of exposure normally encountered in rural areas.

Although preliminary observations indicated that the eyebar failure was responsible for the collapse, laboratory investigations were undertaken to answer many questions such as: Was the steel in the particular eyebar which fractured typical of the steel in other eyebars in the structure; did the eyebar meet construction specifications; was the crack sufficiently large to have caused the brittle fracture at the normal stress level expected at this location; and if so, what was the mechanism by which this defect grew to critical size?

Hardness and metallographic measurements showed that the chemical composition of the steel was in general conformance with the specifications for 1060 carbon steel. The tests showed that the steel met requirements stipulated in the material specifications for the structure. No evidence was uncovered to indicate that this bar was more prone to failure than other bars with a similar history.

The lower side of the eye (straight fracture) fractured under loads that were not sufficient to cause appreciable plastic deformation of the steel.

The faces of both the pre-existing crack associated with the main fracture and similar cracks in adjacent areas were covered with dark oxides of a distinctly different color and texture than surface rusting that developed on the remainder of the fracture surface. Microprobe analyses revealed the presence of more than normal amounts of sulfur in the crack surface. This indicated that sulfur bearing gases such as sulfur dioxide or hydrogen-sulfide in the atmosphere (air pollutants) may have been responsible for the stress-corrosion cracking.

Tests were also performed at the Battelle Memorial Institute and U.S. Steel, complementing the NBS investigation. Of particular interest were fracture toughness tests; these showed that the steel had very low resistance to crack propagation. Calculations based on the results indicated that the crack found in the eyebar was large enough to have initiated the catastrophic fracture under the normal loads to be expected on the bridge. In addition, the Battelle investigation revealed that four of thirty eyebar heads, which were recovered and investigated, had cracks on their pinhole surfaces. Other investigations eliminated the possibility of aerodynamic or traffic vibration excitation as being contributing factors in the bridge collapse.

As a result of the complete investigation, the President-appointed Task Force on Bridge Safety concluded[1] that a small crack, which started at a small corrosion pit and grew to critical size by the joint action of stress-corrosion cracking and corrosion fatigue, was responsible for the bridge collapse.

[1] Highway Accident Report—Collapse of U.S. 35 Highway Bridge Point Pleasant, West Virginia, December 15, 1967, NTSB-HAR-71-1.

Claude Melton extends a seatbelt that has visibly deteriorated due to abrasion. He will measure how many pounds force the seatbelt will withstand on the tensile test machine in the background.

STRENGTH OF USED SEATBELTS

NBS Studies Failures in Old Restraint Systems

AUTOMOBILE SEATBELTS ARE WEAKENED not only by repeated adjustment and use, but also by the mere passage of time after installation. How much they are weakened was studied by engineers of the Office of Vehicle Systems Research (OVSR), which is studying seatbelt performance, among other things, to help the Department of Transportation's National Highway Traffic Safety Administration in setting safety standards for automotive systems. OVSR's Claude Melton and Alfred Castle, Jr., found 68% of the well-used, 3- to 10-year-old seatbelts they tested to be unsafe, based on present Federal standards for seatbelts. (Some of the belts predated Federal consumer seatbelt standards.) They recommend routine testing of seatbelt webbing by an easily used abrasion gage at safety inspection lanes, and replacement of weak belts and all seatbelts manufactured before 1964.

Improvements to new occupant restraint systems are of no help to the majority of drivers and riders who are protected by last year's (or an older) safety belt. For this reason, occupant restraint engineers at the OVSR tested used seatbelts to determine just how much they were weakened by exposure to light, dust, and abrasion with repeated adjustments. The investigation used seatbelts that were suspected of being unsafe and had been removed from service, 64 by the Atomic Energy Commission at its Savannah River, Ga., project and 18 from cars of the Washington, D.C., area. All except two were lap belts; all had been subjected to severe service.

The belts were first inspected for fading, dirt, abrasion, and for corrosion of the hardware. After tests of the buckling action, each belt was tested to failure in a tension apparatus.

Breakage of the webbing was the number one cause of failure. The breaks occurred frequently at points of abrasion—where belts had been worn at the anchor end and at the buckle end due to repeated length adjustments. Wear at these points can reduce the webbing strength of an older belt to a fraction of its initial value in just a few months.

Continued abrasion of the seatbelt webbing causes it to become thicker due to the appearance of "fur"—the protruding ends of broken fibers. This growth in thickness can be used as a measure of abrasion. A quick-reading thickness gage was developed at the Bureau to measure webbing thickness. It passes as a safe webbing one that has grown in thickness less than 0.015 inch, indicates "replace soon" for growth between 0.015 and 0.025 inch, and "definitely unsafe" for growth over 0.025 inch. Further development of this simple device should result in a gage that is ideal for use in auto safety inspection lanes.

Part of each belt is protected from fading in sunlight because of the way the belt is mounted in the car. The researchers tension-tested both ends and found the faded end of each belt to be considerably weaker.

Dirt on the belt was appraised on a some-light-severe scale. The

(*Continued page 207*)

INTERCOMPARISON OF FLUORESCENT LAMPS

AN INTERCOMPARISON OF FLUORESCENT LAMPS was recently carried out under the auspices of the NBS Institute for Basic Standards.[1] The study was carried out in collaboration with an NBS Research Associate (sponsored by the Electrical Testing Laboratories Inc. acting on behalf of the Lamp Testing Engineers' Conference) and with the cooperation of several photometry laboratories. The initial purpose of this intercomparison was to determine whether the use of a new and uniform set of cool white fluorescent lamp standards had improved the agreement among measurements of total luminous flux obtained in laboratories throughout the lamp industry. Many tests were included to answer specific questions concerning the performance of the equipment and the experimental techniques used. In addition, this was the first fluorescent lamp intercomparison to attempt an experimental design that would answer the more general question: What is the present capability of the lamp industry in the fields of photometry and spectroradiometry? Previous intercomparisons were largely data compilations with distribution limited to the participants. In this intercomparison an attempt was made by NBS to interpret the submitted data, to assess the status of photometric and spectroradiometric measurement, and to make the conclusions generally available. Subsequent to the publication of the report, the participants were afforded an opportunity to discuss and question any aspect of the intercomparison.*

In 1968 the Bureau spectroradiometrically calibrated a set of eleven 40-watt, cool white fluorescent lamps by comparing their luminous flux output with a set of 200-watt luminous flux standard incandescent lamps calibrated at 2854 K.[2] Six of these lamps were sent to the Electrical Testing Laboratories (New York, N.Y.) where they were used in a statistically designed procedure to assign total luminous flux values to a group of eighty lamps of the same manufacturer and type. These lamps were then purchased in groups of six by various laboratories as new standards of luminous flux.

For the intercomparison, NBS supplied the participating laboratories with an experimental design, an equipment and procedure questionnaire, and a set of test lamps (two cool white lamps, one daylight lamp, and one 200-watt incandescent lamp). The lamps in the test set were first measured at NBS by both spectroradiometry and conventional photometry. They were then measured at the participating laboratories according to the experimental design. The data and the lamps were then returned to NBS where the lamps were remeasured and the data reduced.

The participating laboratories were asked to measure two properties—total luminous flux and color—of the lamps in the test set in several specific ways. The total luminous flux was measured by three techniques—homochromatic (same relative spectral distribution) substitutional photometry (cool white lamps supplied in the test set versus cool white standards); heterochromatic (different relative spectral distribution) photometry (incandescent and daylight fluorescent versus cool white standards); and total flux, integrating sphere spectroradiometry (cool white and daylight fluorescents versus the incandescent lamp).

The color parameters were obtained by three techniques—total flux, integrating sphere spectroradiometry; spectroradiometry of a 25-cm section of the fluorescent lamp; and colorimetry using a specific colorimeter. In addition, the laboratories were asked to perform an experiment designed to check for systematic errors in substitutional photometry.

GENERAL CONCLUSIONS

Results of the intercomparison show that the precision between laboratories of substitutional photometry is unchanged from previous intercomparisons although the new lamps did provide a more uniform base.

For the measurement of total luminous flux, the most precise method presently in use is homochromatic substitutional photometry (range of agreement, 2 percent). These measurements are rapid and relatively simple to perform; however, a standard of each type of lamp to be measured is required. On the other hand comparison of the luminous flux of two lamps with different spectral distributions, heterochromatic substitutional photometry, was demonstrated to be considerably less precise (range of agreement, daylight versus cool white fluorescent, 3.6 percent; fluorescent versus incandescent, 5.1 percent). If, however, the spec-

(*Continued page 202*)

*This epilogue is available upon request by writing to: E. F. Zalewski, Optical Radiation Section, Heat Division, National Bureau of Standards, Washington, D.C. 20234.

NATIONAL STANDARD REFERENCE DATA SYSTEM
NSRDS NEWS

The NSRDS was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The NSRDS is administered and coordinated by the NBS Office of Standard Reference Data.

APPROACH OF CHEMICAL THERMODYNAMICS DATA CENTER TO FORMULA DESIGNATIONS OF CHEMICAL COMPOUNDS

The Chemical Thermodynamics Data Center, under the direction of D. D. Wagman, National Bureau of Standards, U.S. Department of Commerce prepares an annual index of the published literature on measurements of a number of thermodynamic and related properties (enthalpy, entropy and heat capacity at 298.15 K, and the enthalpy of formation at 0 K) of chemical substances and mixed systems. The index is published as part of the annual *Bulletin of Thermodynamics and Thermochemistry*, under the sponsorship of the Commission on Thermodynamics and Thermochemistry of the International Union of Pure and Applied Chemistry (IUPAC). For this index the Chemical Thermodynamics Data Center based its order of listing on the system used in its compilations of *Selected Values of Chemical Thermodynamic Properties*, NBS Circular 500* and the NBS Technical Note 270** series[1] (SD Catalog numbers C13.46:270-3; C13.46:270-4, $1.25 each; and C13.46:270-5, 55 cents). This system, which covers pure substances and aqueous solutions, gives a uniquely specified location for each substance independent of the manner in which the chemical formula is written or how the substance is named, but keeps together those species that are closely related chemically. It is based on the system originally described by E. W. Washburn in the *International Critical Tables, Vol. I*, p. 96, and has been modified and simplified to include the new synthetic elements and their compounds. It has been further extended to incorporate provisions for alloys and other mixtures and solutions.

*Out of Print

**Updated Revisions of NBS Circular 500

The elements are arranged in the "spread" formation of the Periodic Table and are assigned consecutive "finding numbers," starting with oxygen, next hydrogen, and proceeding down each group of the Table and moving from right to left. The order of the elements and their finding numbers are shown in the accompanying illustration.

The location of any compound is determined by the "finding formula," the set of finding numbers of the elements that constitute the compound. Each substance is located in a table corresponding to the largest finding number in the finding formula. Within each table compounds are arranged in the order of increasing finding number for the other elements. The hydrogen and oxygen due to water of hydration in hydrated salts are not included in the finding formula; hydrates are located immediately after the anhydrous salt. The following sequence of finding numbers illustrates the general principle of the order of arrangement (tables are separated by semicolons):

1; 2,2-1; 3,3-1,3-2,3-2-1; 4,4-1,4-2,4-2-1,4-3,4-3-1,4-3-2,4-3-2-1; etc.

Metal alloy systems and other mixtures and solutions are treated somewhat differently, for the convenience of the users of the Index. Alloy systems, as distinguished from intermetallic compounds, are written with a slash between each of the elements making up the system. They are entered in the tables for each of the elements of the alloy. Within each table the alloy is entered immediately after the pure element, in ascending order of the finding numbers of the remaining elements. Intermetallic compounds, on the other hand, are treated as ordinary compounds and are indexed only in the table corresponding to the highest finding number in the finding formula.

Mixtures and nonaqueous multicomponent solutions are designated with dashes between the component substances. These systems are indexed in the appropriate positions in the various tables corresponding to each of these component substances.

All sorting and ordering of compounds and systems according to the above rules is presently being done by computer, using programs written by W. H. Evans of the Data Center. These programs are

designed to interpret chemical formulae and reactions, written in upper and lower case letters and with superscripts and subscripts, that have been converted into the General Purpose Scientific Document Image Code developed at NBS.***

The elements in the chemical formula for a substance as entered into the computer may be written in any order; the computer determines the proper finding numbers and finding formula and orders the substances as described above. The final order Index as printed by the computer contains the original formulae as they were entered. No attempt has been made to rewrite the chemical formulae of compounds or mixed systems in a format corresponding to the Standard Order, since the multiple index entries make this additional refinement unnecessary.

BIBLIOGRAPHY ON PROPERTIES OF DEFECT CENTERS IN ALKALI HALIDES

NBS-OSRDB-71-1, *Bibliography on Properties of Defect Centers in Alkali Halides*[1] (COM-71-00248, Microfiche 95 cents, Hard Copy $3) by S. C. Jain, S. A. Khan, H. K. Sehgal, V. K. Garg and R. K. Jain is the latest publication of the NBS Office of Standard Reference Data series of bibliographies. References to optical, magnetic, and transport properties of defect centers for impurities and selected molecular ion impurities are surveyed. The defect properties of pure alkali halides are also included. Twenty-five journals were scanned to produce the 3000 references presented in two sections. The first section covers references for the years 1927-1963 inclusively. The second section covers the years from 1964 to the present and is more comprehensive in scope.

***See NSRDS News April 1968 and NSRDS News February 1970.

FOUR TRANSLATIONS OF DATA COMPILATIONS FROM THE U.S.S.R.

Four translations of compilations of thermophysical properties data have been published for the U.S. Department of Commerce and the National Science Foundation and are being made available through the National Technical Information Service. A limited number of copies of each translation are also available on request from Information Services, Office of Standard Reference Data, National Bureau of Standards, Washington, D.C. 20234.

Thermophysical Properties of Freon-22 by A. V. Kletskii[1] ($3, publication from the U.S.S.R. Committee of Standards, Measures and Measuring Instruments, apparently in the series initiated by GSSD (State Service for Standard and Reference Data).

In this book an analysis is made of Soviet and non-Soviet studies on the thermodynamic and physical properties of freon-22, which is one of the most widely used refrigerants. A table is given of the thermodynamic properties of superheated freon-22 vapor in the range -100 to $+250$ °C, at pressures of 0.02-65 bar (1 bar $= 1 \times 10^5$ N/m^2). Tables and thermal diagrams are given of the thermodynamic properties of the gas in a state of saturation (from -105 °C to the critical point). Data on the thermal conductivity, viscosity, surface tension, and dielectric properties of freon-22 are analyzed and tabulated.

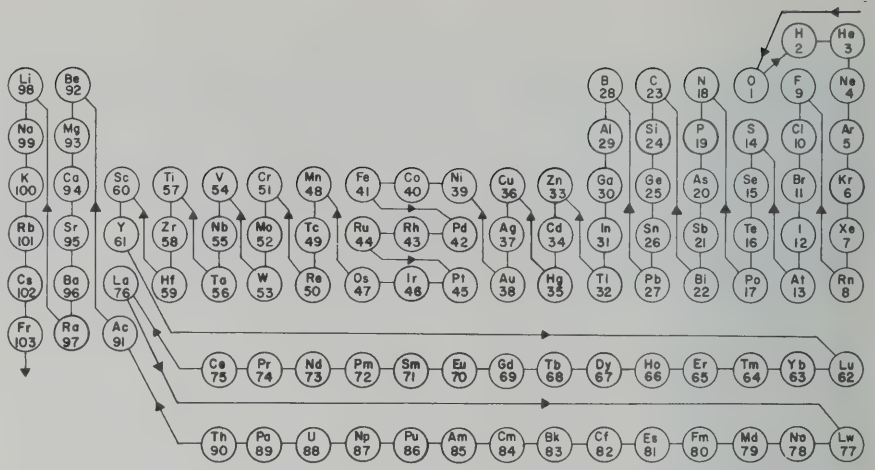
This book will be useful for engineers and technicians working in the field of refrigeration, and for research workers and students of thermal physics. The book has 20 tables, 7 figures, 2 diagrams, and 69 bibliographical references.

Thermophysical Properties of Air and Air Components[1] by A. A. Vasserman, Ya. Z. Kazavchinskii, and V. A. Rabinovich and edited by A. M. Zhuravlev ($3, publication number TT70-50095) describes a method for deriving equations of state from elementary functions conforming to experimental thermodynamic data. The equations of state constructed by this method are sufficiently reliable for computing the thermal and thermodynamic values. A critical analysis is given of the available data on the thermal properties of air, nitrogen, oxygen, and argon. The equations of state for these gases are determined, and detailed tables of their thermodynamic properties are compiled for conditions ranging from the saturation curve to temperatures of 1300 K and pressures of 1000 bar. $T-s$ and $i-s$ diagrams are given for each gas. The experimental data on the viscosity and thermal conductivity of air and its components are analyzed and generalized, and equations are given for computing these properties over a wide range of parameters.

Heavy Water, Thermophysical Properties[1] by Ya. Z. Kazavchinskii et. al. and edited by V. A. Kirillin ($3, publication number TT70-50094) contains a review, a critical analysis, and a synopsis of most of the papers published on the thermophysical properties of heavy water. This material served to derive equations of state for heavy water and its vapor. These equations form the basis of the comprehensive tables given in the book on thermodynamic properties of heavy water for pressures of up to 500 kg/cm^2 and a temperature range between 3.8 and 550 °C.

Thermodynamic and Thermophysical Properties of Helium[1] by N. V. Tsederberg, V. N. Popov, and N. A. Morozova and edited by A. F. Alyab'ev ($3, publication number TT70-50096) contains thermodynamic and thermophysical properties of helium in the ranges of pressure from 0.2 to 200 bar and of temperature from 0 to 3000 °C. An equation of state for helium is given, and the thermal properties are cal-

culated. By means of the rules of statistical thermodynamics, the authors calculated the specific heat, enthalpy, and entropy of helium in the perfect gas state. The influence of the real state of the gas on the thermodynamic properties was estimated from the equation of state for helium. The i—*s* diagram was constructed and equations were formulated for describing the thermal conductivity and the viscosity of helium in given temperature and pressure ranges.



Standard Order of Arrangement of the Elements. Compounds are located in the Table for the element (in the compound) having the highest number in the above figure.

TABLES OF DIELECTRIC CONSTANTS, DIPOLE MOMENTS, AND DIELECTRIC RELAXATION TIMES

The Office of Standard Reference Data has available a limited number of reprints of *Tables of Dielectric Constants, Dipole Moments and Dielectric Relaxation Times* compiled by Worth E. Vaughan of the University of Wisconsin. These Tables are a reprint from the 1969 issue of the *Digest of Literature on Dielectrics* published by the National Academy of Sciences.

The Tables contain unevaluated data reported in publications abstracted by *Chemical Abstracts* for 1969. In most cases the values cited have been taken from the original literature. In cases where the original literature was unavailable, the *Chemical Abstracts* citation follows the reference. The Tables cover measurements on pure materials and dilute solutions but do not include work in mixtures or poorly characterized substances.

The following tables are given:

1. Static Dielectric Constants of Pure Liquids
2. Static Dielectric Constants of Pure Solids
3. Dipole Moments
4. Unresolved Relaxation Times
5. Resolved Relaxation Times

Copies may be obtained from: Information Services, Office of Standard Reference Data, National Bureau of Standards, Washington, D.C. 20234.

[1] Order by number from the National Technical Information Service, Springfield, Va. 22151, for the price indicated.

FLUORESCENT *continued*

tral response of the entire photometric system is a close match to the CIE luminous efficiency function (i.e. the system is color corrected) then heterochromatic and homochromatic measurements become comparable.

For the spectroradiometric measurements of total luminous flux, the range of agreement among the participating laboratories and NBS was found to be 22.6 percent. This was the result of systematic discrepancies between the laboratories a factor of ten greater than the precision within each laboratory (2 to 3 percent). The NBS spectroradiometric and heterochromatic photometric measurements, which are systematically different, agreed to within 0.2 percent. It appears, therefore, that with proper spectroradiometric procedures it should be possible to compare the total luminous flux of two lamps having very different spectral distributions to a precision close to that of homochromatic substitutional photometry. Furthermore, since it is difficult to produce and maintain reliably stable standard sources, the expense and effort necessary to set up and maintain a photometric system for each possible source would be comparable to or might possibly exceed that of a single spectroradiometer.

The range of agreement obtained from spectroradiometric measurement of color parameters was better than that obtained with the colorimeter. In addition the spectroradiometric data acquired for a single spectral flux distribution measurement permit the calculation of all the color parameters (chromaticity coordinates, color temperature, color rendering, flattery index, etc.), thereby replacing all other color measuring instruments.

Eventually, a well developed spectroradiometric laboratory may need only a few highly stable standards of flux and spectral distribution from which to derive accurate secondary standards of each lamp in production. These secondary standards would then be used in homochromatic substitutional photometry for routine quality control testing and other intralaboratory requirements.

[1] For complete details, see McSparron, D. A., Mohan, K., Raybold, R. C., Saunders, R. D., and Zalewski, E. F., Spectroradiometry and Conventional Photometry—An Interlaboratory Comparison Nat. Bur. Stand. (U.S.), Tech. Note 559 (Nov. 1970).

[2] Improved fluorescent lamp calibration, Nat. Bur. Stand. (U.S.), Tech. News Bull. 52 (8), 171 (Aug. 1968).

FIPS NOTES

NEW FIPS TASK GROUPS ON COBOL AND COMPUTER PERFORMANCE

The NBS Center for Computer Sciences and Technology recently authorized the formation of two additional Federal Information Processing Standards Task Groups—Nos. 9 and 10.

The purpose of FIPS Task Group No. 9, COBOL Standard, is to:

(1) Develop recommendations to the National Bureau of Standards that revise the content of the currently proposed Federal COBOL Standard responsive to Government users' needs.
(2) Develop recommendations on the organization of the standard, both physical (printed format) and logical (subsets and levels) that are consistent with Government-wide objectives on the management of the COBOL standard.
(3) Establish a dialogue with the Government COBOL community that insures a wide spectrum of user participation in the work of the task group.

Under its program of work, the task group is to:

(1) Recommend desirable revision to AN Standard COBOL, X3.23-1968, based on the CODASYL Journal of Development 1970 and ANSI Committee X3J4's current activities and actions.
(2) Recommend desirable changes and location of new language elements in existing subsets and levels.
(3) Prepare document reflecting recommendations of 1 and 2 above.
(4) Prepare recommended changes to COBOL FIPS PUB relating to language specifications.
(5) Develop appropriate Government recommendation for inclusion into the future COBOL standards work of the ANSI X3J4 Committee and CODASYL.

The purpose of FIPS Task Group No. 10, Guidelines for Computer System and Component Performance Evaluation, is to identify and recommend to the FIPSCAC, guidelines for hardware and software component evaluation criteria, measurement techniques and procedures that may be applied throughout the Federal Government to aid in:

(a) Installation operational improvement.
(b) Computer system and component selection.

Under its program of work FIPS TASK Group 10 is to:

(1) Establish, and function on a continuing basis, as an interagency forum and point of contact for exchanging information on computer systems and component performance evaluation techniques and procedures currently in use by Government and industry.
(2) Identify and define technically valid system and component performance evaluation criteria, parameters to be measured, and measurement techniques and procedures. Specific areas of investigation will include:
   a. Simulation
   b. Hardware and software monitors
   c. Benchmarks
   d. Analytic methods
(3) Prepare recommendations for FIPS Coordinating and Advisory Committee (FIPSCAC) consideration and approval with respect to Government-wide guidelines of system and component performance measurement techniques and procedures as either:
   a. Uniform practices
   b. Federal standards

Participation in these task groups is being solicited through the Interagency Committee on ADP. Persons interested in contributing to these efforts should consult their agency's principal member of the Interagency Committee on ADP. Additional details concerning these task groups may be obtained by writing the NBS Office of Information Processing Standards.

ISO STANDARDIZES STANDARDIZATION TERMS

The Council of the International Organization for Standardization (ISO) has approved thirteen terms and their definitions for use in standardization work. These terms will constitute the first part of a vocabulary of basic terminology which will enable those participating in standardization work to communicate

easily and accurately and avoid the danger of ambiguity and misunderstanding. The terms were defined by ISO's Standing Committee for the Study of Principles of Standardization (STACO), an international committee of experts which advises the ISO Council on Fundamental Problems Relating to Standardization.

The thirteen terms and their definitions read as follows:

1. Standardization

The process of formulating and applying rules for an orderly approach to a specific activity for the benefit and with the cooperation of all concerned and in particular for the promotion of optimum overall economy taking due account of functional conditions and safety requirements.

It is based on the consolidated results of science, technique and experience.

It determines not only the basis for the present but also for future development and it should keep pace with progress.

Some particular applications are:

(1) units of measure;
(2) terminology and symbolic representation;
(3) products and processes (definition and selection of characteristics of products, testing and measuring methods, specification of characteristics of products for defining their quality, regulation of variety, interchangeability, etc.);
(4) safety of persons and goods.

2. Standard

The result of a particular standardization effort, approved by a recognized authority. It may take the form of

(1) a document containing a set of conditions to be fulfilled (in French "norme")
(2) a fundamental unit or physical constant, for example, ampere, metre, absolute zero (Kelvin). (In French "étalon.")

3. Specification

A concise statement of a set of requirements to be satisfied by a product, a material or a process indicating, whenever appropriate, the procedure by means of which it may be determined whether the requirements given are satisfied.

Notes:

(1) A specification may be a standard, a part of a standard, or independent of a standard.
(2) As far as practicable, it is desirable that the requirements are expressed numerically in terms of appropriate units, together with their limits.

4. Simplification (variety reduction)

A form of *standardization* consisting of the reduction of the number of types of products within a definite range to that number which is adequate to meet prevailing needs at a given time.

5. Unification

A form of *standardization* consisting of combining two or more *specifications* into one, in such a way that the products obtained are interchangeable in use.

6. Specialization

This term is properly speaking not within the sphere of standardization. If it is used, it should have the following meaning:

> A process by which particular production units concentrate on the manufacture of a limited number of kinds of products.

7. Functional interchangeability

This condition is achieved when those characteristics of the finished product which affect its operation (frequently including characteristics other than linear dimensions) have been *standardized* to the necessary degree of accuracy.

8. Dimensional interchangeability

A partial aspect of *functional interchangeability;* being a condition which is achieved when the linear dimensions of two finished products are sufficiently close to one another to ensure only interchangeable replacement.

9. Designation

A definite and distinguishing name or symbol given to a product or to a group of functionally similar products or to an abstract matter. It underlines the group similarity but does not bring out the differences between the various members of the group.

Note.—The use of two or more names for a single product is confusing; selection of the most appropriate term as the standard designation should be undertaken at an early stage in the standardization of the product itself (for example "capacitor" may be selected as the standard designation of an electrical device for which the term "condenser" has also previously been used).

10. Identification

The recognition of the nature of a product or abstract notion in such a way as to permit the proper designation to be applied to it.

The product may be identified in broad terms only, as one of a certain group, or its characteristics (size, etc.) may be identified, thus distinguishing it from other members in the group.

To facilitate identification, marking by means of a number, color or other such indication may be used.

11. Code

A particular form of *identification* marking or reference which serves the dual purpose of establishing in a systematic manner the complete identity of an individual product and of bringing out

at the same time its similarity with other products.

It may consist of a brief and systematic combination of letters, numerals and/or symbols. A systematic code, used in conjunction with a key for decoding, can assist identification of a product and enable its characteristics to be known.

12. Coding

The action of devising a *code*.

13. Marking

The action and the result of stamping, inscribing, printing, labelling, etc. marks, symbols, numerals, letters, etc. upon a product itself or on its package, for the purpose of *identifying* the product and its origin, and giving its basic characteristics, its intended use, etc.

Note.—In the manufacturing of products, the term "marking" is also used with another meaning when it concerns
marking of outlets
terminal markings.

ANNEX

The following terms have been adopted by STACO and will be published later with their definitions subject to approval by the ISO Council:

Quality
Tolerance
Calibration
Performance specification
Fitness for use

The following terms are under discussion by STACO:

Standardization subject
Standardization domain
Standardization requirement
Standardization aspect
Standardization level
Standardization problem
Standardization space
Class
Type
Grade

CONTROLS FOR MAINTAINING A PROPER COMPUTER ROOM ENVIRONMENT ESTABLISHED

The Administrator of the General Services Administration, Robert L. Kunzig has approved an amendment to the Federal Property Management Regulations (Part 101-32),[1] relating to the Government-wide use of automatic data processing management services. This amendment, effective November 19, 1970, provides direction and establishes controls for maintaining a proper computer-room environment and provides guidance for computer-room fire safety practices.

Included under computer room environment are controls for temperature and humidity, lighting and electrical service, noise level, personnel traffic, cleanliness, storage areas, precautionary measures, employee briefings, and computer room inspection. The subpart on fire prevention in the computer room provides guidance on fire emergency staffs, firefighting teams, portable firefighting equipment, and firedrills and other related training.

Additional information and assistance regarding the guidelines contained in the above amendment is available to agencies by writing to: General Services Administration, Federal Supply Service, Office of Automated Data Management Services (FT), Washington, D.C. 20406.

[1] Published in FEDERAL REGISTER, Vol. 35, No. 225, November 19, 1970, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 20 cents.

HYDROGEN *continued*

themselves by more than their own accuracy claims. Those measurements either were limited to a few bulb sizes or used a wall-shift correction that was not directly related to the particular maser being measured. A wall-shift correction valid for one bulb will not be valid for another, except for the unlikely case in which all parameters are duplicated. The amount of wall shift depends on the bulb dimensions, bulb temperature, method of wall preparation, and coating on the walls.

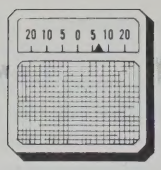
One experiment at NBS relied on a wall-shift measurement made at Harvard University.[3] The frequency of the Harvard maser was compared to the NBS-III standard by using a portable and very stable hydrogen maser (furnished by SAO) as a transfer standard. This procedure gave a value of the unperturbed hydrogen frequency when the wall-shift correction and all other bias corrections were added to the measured frequency.

In the other experiment, an NBS maser, equipped with bulbs ranging from 7.5- to 20-cm in diameter, yielded eleven valid frequency measurements. The measurement procedure differed from any previous wall-shift measurement. A NASA reference oscillator, related accurately to NBS-III, was used to evaluate the wall shift. This meant that the wall-shift measurements and the hydrogen-cesium frequency comparison were integral parts of the same experiment, resulting in an accuracy of better than two parts in 10^{12}.

[1] Hellwig, H., et. al., Measurement of the unperturbed hydrogen hyperfine transition frequency, IEEE Transactions on Instrum. and Meas. IM-19, No. 4, 200-209 (Nov. 1970).

[2] NBS-III is the evaluated laboratory cesium beam standard of NBS which serves to realize the unit of time interval (the second) in accordance with the internationally recognized definition. See, D. J. Glaze, Improvements in atomic cesium beam frequency standards at the National Bureau of Standards, IEEE Transactions on Instrum. and Meas., IM-19, No. 3, 156-160 (Aug. 1970).

[3] Zitzewitz, P. W., et. al., Recent results concerning the hydrogen maser wall shift problem, Rev. Sci. Instr., **Vol. 41,** 81-86 (1970).



STANDARDS AND CALIBRATION

BROADCAST OF NEW TIME SCALE

Since 1967 the second has been defined in terms of an atomic transition, while time scales in general use are based on the rotation of the earth. This has resulted in the dissemination of a compromise time scale arrived at by international agreement through the International Radio Consultative Committee, and maintained by the International Bureau of Time (BIH). This scale, known as Coordinated Universal Time (UTC), presently operates with a frequency offset from the atomic scale of -300×10^{-10} to approximately agree with the rotation of the earth. Occasional step adjustments in time of 0.1 second are also made to compensate for unpredictable variations in the earth's rate of rotation.

To avoid the disadvantages of having an offset frequency and fractional second step adjustments, the UTC time scale will change on 1 January 1972. The new UTC scale will operate with a frequency offset, thus providing time intervals that are exactly one second long. The scale will continue to keep in approximate agreement with earth time, known as UT1, by step adjustments of exactly one second occurring about once per year. There will be a preference of adjustments on the 1st of January and July. In any case the new UTC scale should not differ from UT1 by more than 0.7 second.

In the U.S., therefore, the NBS standard broadcast services of WWV, WWVH, and WWVL will be changed to have zero offsets in their carrier and modulation frequencies and time signals. At 00 hours on 1 January 1972, UTC will be reset a fraction of a second, sufficient to give the new UTC scale an initial difference of an integral number of seconds (probably 10.000 seconds late) with respect to International Atomic Time (IAT) as maintained by the BIH. UTC is now about 9 seconds late compared to IAT, and during the next year the difference will probably increase to about 10 seconds; thus, the reset should be only a few hundred milliseconds. Thereafter, the difference between UTC and IAT will always be an integral number of seconds. The difference between UT1 (not UT2) and the broadcast signal will also be given after 1 January 1972, probably with a resolution of 0.1 second.

STANDARD FREQUENCY AND TIME BROADCASTS

High-frequency radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast time signals on the Coordinated Universal Time (UTC) system as coordinated by the Bureau International de l'Heure (BIH), Paris, France. The NBS time scale, UTC(NBS), and the U.S. Naval Observatory time scale, UTC(USNO), are jointly coordinated to within ±5 microseconds. The UTC pulses occur at intervals that are longer than one coordinated second by 300 parts in 10^{10} during 1971, due to an offset in carrier frequency coordinated by BIH. To maintain the UTC scales in close agreement with the astronomers' time, UT2, phase adjustments are made at 0000 hours Greenwich Mean Time (GMT) on the first day of a month as announced by BIH. *There will be no adjustment made on September 1, 1971.*

The low-frequency radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses without offset to make available to users the standard of frequency so that absolute frequency comparisons may be made directly, following the Stepped Atomic Time (SAT) system. Step time adjustments of 200 ms are made at 0000 hours GMT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be an adjustment made on September 1, 1971. The seconds pulses emitted from WWVB will be retarded 200 ms.*

NBS obtains daily UT2 information from forecasts of extrapolated UT2 clock readings provided by the U.S. Naval Observatory with whom NBS maintains close cooperation.

FRINGE-COUNTING *continued*

million can be obtained by this method.

The interferometer does not pose any hard-to-meet restrictions not inherent in any high-precision manometer. Among the most stringent requirements are good temperature control, maintenance of verticality, large diameter of the column, purity of the mercury, and vibration isolation. Vibration isolation and temperature stabilization are more easily perfected in an ultrasonic interferometer manometer than in any other type of precision manometer because of the absence of moving parts and the automatic operation.

[1] Heydemann, P. L. M., A fringe-counting, pulsed ultrasonic interferometer, Rev. Sci. Instrum. Vol. 42, No. 7 (July 1971).

Postdoctoral Research Associates Named

The 17th Annual competition for Postdoctoral Research Associateships sponsored by the National Research Council, the National Academy of Sciences, the National Academy of Engineering, and the National Bureau of Standards, has recently been completed. Seventeen scientists were appointed to NBS to conduct research in various fields of the physical sciences and engineering for the coming year. The Postdoctoral Research Associateship Program, supported financially by the Bureau and administered by the National Research Council, provides further training through advanced research under the guidance of senior NBS scientists. The selectees, their schools, and their NBS advisors are:

John H. Albers; Ph. D. in chemistry from the Massachusetts Institute of Technology; Dr. R. D. Mountain Heat Division

George H. Atkinson; Ph. D. in chemistry from the Indiana University; Dr. R. A. Keller Physical Chemistry Division

Frank P. Billingsley; Ph. D. in chemistry from the University of Virginia; Dr. M. Krauss Physical Chemistry Division

Marvin Bishop; Ph. D. in chemical physics from Columbia University; Dr. E. A. DiMarzio Polymers Division

Harry S. Camarda; Ph. D. in physics from Columbia University; Dr. H. H. Landon Nuclear Radiation Division

James F. Ely; Ph. D. in chemistry from the Indiana University; Dr. D. E. Diller Cryogenics Division-Boulder

Clark A. Hamilton; Ph. D. in electrical engineering from the University of Rochester; Dr. R. A. Kamper Cryogenics Division-Boulder and Dr. Kenneth Evenson Quantum Electronics Division-Boulder

Camden R. Hubbard; Ph. D. in chemistry from Iowa State University; Dr. F. A. Mauer Inorganic Materials Division

Charles E. Hughes; Ph. D. in computer science from the Pennsylvania State University; Dr. R. M. Davis Center for Computer Sciences and Technology

Joel F. Liebman; Ph. D. in chemistry from Princeton University; Dr. T. D. Coyle Inorganic Materials Division

James J. Murphy; Ph. D. in physics from the University of Illinois; Dr. W. R. Dodge Linac Radiation Division

Robert C. Reno; Ph. D. in physics from Brandeis University; Dr. L. H. Bennett Metallurgy Division

Raymond C. Sansing; Ph. D. in statistics from the Southern Methodist University; Dr. J. R. Rosenblatt Applied Mathematics Division

Emil Simiu; Ph. D. in structural engineering from Princeton University; Dr. E. O. Pfrang Building Research Division

Michael Simmonds; Ph. D. in physics from the University of California-Irvine; Dr. J. E. Zimmerman Cryogenics Division-Boulder

Arthur D. Yaghjian; Ph. D. in electrical engineering from Brown University; Dr. D. M. Kerns Electromagnetics Division-Boulder

Gerald A. Zerdy; Ph. D. in electrical engineering from the University of Maryland; M. Greenspan Mechanics Division

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NEUTRON *continued*

analysis of tree-ring sections from very old trees to analyze the build-up of pollutants since the Industrial Revolution. An essential feature of this work is in the development of monitors that will incorporate accurately known amounts of the various pollutants as reference standards for comparative analysis.

The role of trace metals in healing bones is being investigated through neutron activation analysis at the reactor by dental researchers from the U.S. Army Institute of Dental Research. Injections of zinc, manganese, or copper, given to experimentally injured animals, have been shown to be effective in accelerating bone healing. Zinc has been particularly effective while toxic effects were noted with copper. The techniques involved show promise of having final application in the human.

[1] For more complete details, see Carter, R. S., Reactor Radiation Division: Annual Progress Report for the Period Ending October 31, 1970, Nat. Bur. Stand. (U.S.), Tech. Note **567,** 66 pages (Mar. 1971).

[2] Research at NBS reactor, Nat. Bur. Stand. (U.S.), Tech. News Bull. **54,** No. 8, 174-176 (Aug. 1970).

SEATBELTS *continued*

presence of dirt reduced belt strength and its long-continued presence could be a factor determining how much abrasion takes place.

Corrosion was not found to greatly affect the strength of the hardware of belts from the Savannah and Washington areas. However, buckles did not do well on the tilt lock angle test, which measures the capability of the webbing adjustment clamping device, and the release force tests. About 25% of them failed to lock at the 30° minimum between buckle base and webbing. Many buckles had latching and release defects.

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Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $9.50; foreign, $11.75. Single copy price varies. SD Catalog No. C13.22/sec.A:74.

Section B. Mathematical Sciences. Issued quarterly. Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25. SD Catalog No. C13.22/sec.B:74.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25. SD Catalog No. C13.22/sec.C:74.

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Franklin, A. D., Bennett, H. S., Editors, ARPA-NBS program of research on high temperature materials and laser materials, Reporting Period July 1 to December 31, 1970, Nat. Bur. Stand. (U.S.), Tech. Note 574, 44 pages (May 1971) 50 cents, SD Catalog No. C13.46:574.

Furcolow, W. H., Technical Standards Coordinator, Clinical thermometers (Maximum-self-registering, mercury-in-glass), Nat. Bur. Stand. (U.S.), Prod. Stand. 39-70, 12 pages (May 1971) 15 cents, SD Catalog No. C13.20/2:39-70.

Garner, E. L., Machlan, L. A., Shields, W. R., Standard Reference Materials: Uranium isotopic standard reference materials, (Certification of uranium isotopic standard reference materials), Nat. Bur. Stand. (U.S.), Spec. Publ. 260-27, 162 pages (Apr. 1971) $1.25, SD Catalog No. C13.10:260:27.

Harman, G. G., Kessler, H. K., Application of capacitor microphones and magnetic pickups to the tuning and trouble shooting of microelectronic ultrasonic bonding equipment, Nat. Bur. Stand. (U.S.), Tech. Note 573, 24 pages (May 1971) 35 cents, SD Catalog No. C13.46:573.

Hustvedt, E. H., Conference Coordinator, Friend, M. L., Editor, Proceedings of joint meeting of government operations research users and producers, Held at the National Bureau of Standards, Gaithersburg, Md., June 5-6, 1969, Nat. Bur. Stand. (U.S.), Spec. Publ. 347, 164 pages (May 1971) $1.25, SD Catalog No. C13.10:347.

Lloyd, E. C., Editor, Accurate characterization of the high-pressure environment, Proceedings of a Symposium held at the National Bureau of Standards, Gaithersburg, Md., October 14-18, 1968, Nat Bur. Stand. (U.S.), Spec. Publ. 326, 343 pages (Mar. 1971) $4.50, SD Catalog No. C13.10:326.

Mukerjee, P., Mysels, K. J., Critical micelle concentrations of aqueous surfactant systems, Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 36, 227 pages (Feb. 1971) $3.75, SD Catalog No. C13.48:36.

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